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How installers select and explain domestic heating controls

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ABSTRACT

Though central heating controls have the potential to reduce the energy consumed through domestic space heating, their installation does not guarantee savings. End users do not always understand their controls, or operate them in an energy-efficient way, but there is little appreciation of why this is. Drawing on an ethnographic study, this paper investigates how installers select and explain central heating controls. With reference to the concept of technology scripting, which suggests that the assumptions made about users during the design of devices can influence their eventual use, it shows how heating installers also draw on certain user scripts. Through these means the paper illuminates the significant role that heating installers play in influencing the control products fitted into homes, and how they might be used. Though their use of these scripts is understandable, it is not always conducive to ensuring that central heating systems are operated in the most energy-efficient way. It is suggested that industry and policy-makers might engage with how installers understand users and revise current guidelines to foster better communication between them.

KEYWORDS

control systems; energy demand; heating; installer; socio-technical; space heating

Introduction

The European Union (EU) has set a long-term goal of reducing its greenhouse gas emissions by 80–95% when compared with 1990 levels by 2050 (EC, 2011). Though meeting these ambitious targets will require effort across a range of sectors, influencing how people live with the existing building stock must be an important part of this. This is especially true because buildings are responsible for approximately 40% of the energy consumed in the EU, with space heating being particularly significant (EC, 2012). This paper focuses on the UK context, where space heating is the largest single contributor to domestic energy consumption and this value has remained persistently high over the last 40 years (Palmer & Cooper, 2013, p. 35). Since the vast majority of households heat their properties through central heating (ONS, 2011), this technology should be a key focus.

Technological strategies seeking to reduce the energy consumed through central heating have been implemented through setting standards via building regulations, and are based on the understanding that the installation of advanced technologies will result in energy savings. For example, Part L of the Building

Regulations stipulates that fixed building services must ‘have effective controls’ (HM Government, 2010, p. 39). The minimum control requirements are a programmer with independent controls for heating and hot water, a room thermostat and thermostatic radiator valves (TRVs) on all radiators except in rooms with a room thermostat. However, a review of claims made about the savings potential of heating controls found that they lack rigorous supporting evidence (Shipworth et al., 2010, p. 52). Furthermore, the energy savings achieved through the addition of controls are dependent on various factors that include the physical composition of the building, economics (e.g. fuel costs) and both installer and user understanding of these devices.

Of these, user understanding has been a focus for policy-makers based on the belief that, for the energy-saving potential of heating controls to be realized, ‘occupants must actively program the thermostat and select settings that result in savings’ (Peffer, Pritoni, Meier, Aragon, & Perry, 2011, p. 2535). Achieving energy savings and comfort is difficult, and can be influenced by variable occupant lifestyles (Huebner et al., 2013), but also physical building parameters (Love, 2014). However,

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policy-makers have targeted end users via information campaigns, based on the hope that, with the provision of information, end users will lower their thermostat settings in a bid to save money and energy (Burr, 2008). This is in line with wider policy assumptions about how home heating is most effectively influenced (Lutzenhiser, 2014; Moezzi & Lutzenhiser, 2010). Information campaigns have primarily focused on the thermostat, encouraging householders to reduce set points by 1°C. For example, the Energy Saving Trust website states: 'Turn down your room thermostat by one degree to save about £85–£90 and 310 kg–360 kg carbon dioxide a year,' but no citations are given for the advertised savings (EST, 2014). However, these information campaigns have been shown to result in only 'modest behavioural changes' (Steg, 2008) and, although they can increase users' level of knowledge, there is little evidence that they affect actual energy use (Abrahamse, Steg, Vlek, & Rothengatter, 2005).

Both technological strategies and information campaigns fail to account for the ways in which end users' interaction with these devices might be affected by other influences. In particular, there has to date been little consideration of how particular central heating controls come to be in the home and the social actors who help select relevant devices and advise occupants on their use. Central heating installers¹ are one such group. In the UK, these actors are tasked with the design, selection, installation and commissioning of central heating systems, including central heating controls. With this in mind, the research question this paper seeks to address is: how might installers influence the use, and subsequent energy consumed through, domestic central heating systems through the selection and explanation of controls?

The paper proceeds by detailing the existing evidence on the role of installers in influencing the types of controls installed in homes and their use. Following this, the method and analytical approach applied are elaborated. This paper draws on ethnographic data collected through shadowing, observing and interviewing heating installers in a range of settings. It analyses this with reference to the social theory of user 'scripting', which suggests that the use of technologies can be shaped by the assumptions about users made during design and development processes (see the abstract). The findings are presented in two sections: the first investigates installers' selection of controls, whilst the second details their explanation strategies. The findings provide important insights for policy-makers seeking to reduce the energy consumed through central heating by demonstrating how the understandings of end users applied by installers when selecting and explaining controls might influence subsequent energy use. This paper closes with a discussion

of how industry and policy-makers might engage with heating installers' practices to influence the types of controls installed and the explanations that accompany them.

Literature on heating controls and the role of the installer

Installers' influence on the selection of controls

Decisions about the central heating controls installed may include consideration of the physical parameters of the building and central heating system, along with the economic and aesthetic priorities of both installers and occupants. Despite this, a rapid evidence review that focused on how heating controls affect energy demand in the UK context found that 'installers, rather than domestic consumers frequently make decisions about which central heating controls to install and where to install them' (Munton, Wright, Mallaburn, & Boait, 2014, p. 7). However, the authors note that they found 'very little robust empirical evidence with regard to questions of when, why and how new heating controls are installed' (p. 29). With regard to boilers, survey research has suggested that over half of UK householders left the choice to the installer (Banks, 2000a, 2000b). Meanwhile, in a study of the market penetration of condensing boilers within the EU, Weber et al. suggest 'the role of installers cannot be overestimated' (Weber, Gebhardt, & Fahl, 2002, p. 313). In the UK an average of 1.6 million new boilers were installed each year between 2008 and 2012 (CCC, 2014, p. 164). Although data on the replacement rates of heating controls are unavailable, they are often replaced alongside a new boiler in order to comply with current Building Regulations. Despite the apparent significance of the installer in the selection of boilers, their role in influencing the selection of controls has not yet been investigated.

If, as this evidence suggests is likely, heating installers play a role in determining the controls fitted in homes, it is important to investigate whether 'usable' devices are being fitted. Usability is defined as 'the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use' (BSi, 1998, p. 2). Poor usability can mean that controls are rarely adjusted, or simply not used (Caird & Roy, 2008; Rathouse & Young, 2004). A shift in the design of central heating controls towards a 'product resembling software or consumer electronics' (Peffer et al., 2011, p. 2533), along with the use of small buttons and fonts (Combe, Harrison, Craig, & Young, 2012; Rathouse & Young, 2004) and difficulty in understanding abbreviations, terminology and symbols (Combe et al., 2012; Karjalainen, 2007), have all

been identified as problems by users of these devices. Furthermore, there is a growing body of evidence that older people are vulnerable to exclusion from digital heating controls (Caird & Roy, 2008; Combe, Harrison, Dong, Craig, & Gill, 2011; Combe et al., 2012; Combe, Harrison, & Dong, 2013; Sauer, Wastell, & Schmeink, 2009). If poor usability limits end users' interaction with their heating controls, it is essential to investigate what heating controls are being selected for different users and whether the products being fitted are indeed 'usable' for these individuals. However, end users' interaction with these devices may also be influenced by their understandings. This is a second aspect for which heating installers' potential role has been identified, but not yet investigated.

Installers' influence on the use of controls

Heating installers have been identified as potentially influential in shaping users' understandings of their controls. Rathouse and Young conducted a series of focus groups with users, and found that those with a detailed understanding of their controls had generally gained it through 'their jobs or carrying out DIY ['do-it-yourself' home repairs]', whilst those with less understanding were influenced by 'family, friends, official information' (Rathouse & Young, 2004, p. 17). The authors did not identify what this 'official information' might be, or through what channels it came, but later reported that their participants noted asking 'installers, plumbers and engineers to show them how to use their controls and sometimes to set their programmers' (p. 24). The authors also highlight that experiences with installers varied amongst their participants, but do not elaborate further. Thirty years ago, Kempton noted that information about thermostats was 'communicated almost entirely through folk channels' (Kempton, 1986, p. 77), highlighting how they are not formally studied in school, for example. However, he does not elaborate on what these folk channels might be. Meanwhile, occupants questioning the most efficient operating strategy for their central heating system have also identified friends and heating installers as influential (Rubens & Knowles, 2013).

The Heating and Hotwater Industry Council (HHIC), a trade association that represents the UK domestic heating market, has developed a Commissioning Checklist designed to guarantee the standards of central heating installation. This stipulates that installers are required to 'demonstrate the operation of the boiler and system controls', and to ensure that they are 'understood by the customer' (HHIC, 2014). Aside from this, there is very little guidance for installers on how to select, install and explain controls. The Chartered Institute of Building

Services Engineers (CIBSE) has developed the *Domestic Heating Design Guide* (CIBSE, 2013), and the Energy Saving Trust has provided advice for installers in the past (e.g., EST, 2008). With these limited resources, installers are often reliant on informal processes of learning from peers (Wade, Hitchings, & Shipworth, 2016), and information from manufacturers.

Exactly how heating installers might influence these understandings has yet to be investigated. 'Considerable disagreement' has been identified amongst focus group participants about the most efficient way to operate a central heating system (Rathouse & Young, 2004, p. 17). Some people favoured using the system intermittently, whilst others preferred to keep it on constant – under the understanding that it takes more energy to heat the home from cold than keep it at a constant temperature (Rathouse & Young, 2004). Furthermore, individuals do not always recognize that they have particular controls (Revell & Stanton, 2014), and are not always able to distinguish the controls that they do have or what these devices do (Rathouse & Young, 2004). In particular, occupants conceptualize their room thermostats in different ways, with some recognizing and using them as on/off switches (Caird, Roy, Potter, & Herring, 2007; Rathouse & Young, 2004), or according to certain 'folk theories' (Kempton, 1986). Thus, mixed understandings have been identified amongst users about the most efficient way to operate their central heating system, and heating installers have been identified as influencing these understandings. However, the messages that installers provide during the installation of heating controls have not yet been investigated.

Method

Data collection

The following empirical insights are derived from ethnographic fieldwork exploring the installation practices of heating installers in the UK, conducted between September 2012 and December 2013. The strength of detailed ethnographic approaches has previously been demonstrated in studies of domestic energy use (Kempton & Krabacher, 1984; Wilk & Wilhite, 1985; Wilhite, Nakagami, Masuda, Yamaga, & Haneda, 1996). Consistent with the ethnographic rationale of retaining an open approach, this fieldwork proceeded by spending an extended amount of time with heating installers, during which, the role of the researcher was one of:

Watching what happens, listening to what is said, and/or asking questions through informal and formal interviews, collecting documents and artefacts – in fact

gathering whatever data are available to throw light on the issues that are the emerging focus of inquiry.

(Hammersley & Atkinson, 2007, p. 3)

Key to the ethnographic approach is the emergent nature of the research findings and focus. Thus, this fieldwork was not limited to particular strategies or settings, but was directed by what yielded the most fruitful and relevant data. In this instance it comprised conducting 20 semi-structured interviews with heating installers, shadowing a range of installers approximately 30 times as they went to fit systems in domestic properties, observing nine training sessions hosted by boiler and controls manufacturers, and spending one week in plumbers' merchants. Collectively, this study therefore involved approximately 400 hours spent with heating installers in a variety of settings. The shadowing and observation were conducted overtly and resulted in the collection of photographs and detailed field notes, ranging from 4000 to 10,000 words in length. Meanwhile the interviews were conducted in a location of the installer's choosing and probed topics including the installer's background, how they felt about their profession, and their strategies for installing systems and interacting with customers. These lasted between 45 minutes and three hours in length, and were audio recorded and transcribed verbatim.²

Killip has noted the difficulty of studying those working in the construction sector using qualitative methods because potential informants 'lack the time to participate' (Killip, 2011, p. 188). Further, heating installers primarily work individually in a closed setting – the private home, meaning that observation opportunities were not readily accessible. In view of these challenges, data collection relied on a 'snowball' approach in which key informants recommended additional participants as the study gained momentum. This included attending industry events, for example manufacturer training days, building rapport with existing contacts and asking them to act as gatekeepers by providing connections and recommendations for subsequent research.

Access to participants for this research was reliant on this approach, which resulted in some limitations in the sample. For example, using contacts as gatekeepers influenced the determination of participants for this investigation. For example, they suggested those that were trusted and highly regarded, amidst concerns about how the industry would be portrayed (Hammersley & Atkinson, 2007, p. 51). Furthermore, recruiting heating installers at training sessions led to a certain degree of self-selection. Whilst not always the case, those attending training sessions were likely to be most interested in updating and maintaining their expertise. Thus, this sample is limited to those who regard themselves, and

are regarded by others, as performing high quality work, the majority of whom had been operating in the industry for many years. However, participants were recruited through several different industry events and gatekeepers, meaning that a range of perspectives were captured. This sampling approach resulted in data from interactions with over 100 heating installers.

Several of the participants were self-employed heating installers (or operating their own micro-enterprises with between one and five other employees), working primarily in private homes. The sample also included staff from several medium-sized organizations, who had contracts with registered social landlords (RSLs) to perform heating installation and maintenance work across their housing portfolios. The majority of shadowing and observation took place within Greater London; however, through training sessions and interviews, the sample also includes heating installers working in Somerset and the Midlands. These participants were all male, and aged between 25 and 65 years. They had a variety of backgrounds, qualifications and routes into the industry, but the majority had been working as heating installers for over 10 years. Whilst not statistically representative of the approximate 135,000 heating installers operating in the UK,³ this sample does reflect the diversity of this group. The workforce of those qualified to work on domestic gas is composed of 73% sole traders, 19% small businesses and only 8% large business (GSR, 2011, p. 22). The present study sample also included those working within both social and private housing, and captured the different strategies that self-employed individuals and organizations use to complete an installation. The anonymity of all heating installers, brands and locations has been protected by the use of pseudonyms.

Data analysis

The data collected was analysed using maxQDA qualitative analysis software (maxQDA, 2016), and coded through a process of moving back and forth between emergent themes and relevant social theory. Themes are general areas of interest that were identified from the data according to recurrent ideas and events. A systematic process of identifying and coding data, and aligning it with relevant themes was conducted. However, 'bringing structure, order and interpretation' to the volume of collected data did not proceed in a linear fashion; instead this was an incremental, iterative, time-consuming process (Marshall & Rossman, 2006, p. 154). This analysis also draws on the concept of scripting to investigate how installers might influence the use of heating controls. This is introduced below before proceeding to the empirical material, which includes data that has

been selected to demonstrate recurring themes and ideas that were both identified in the broader sample and relevant to this idea of technology scripting.

The concept of scripting stems from science and technology studies (STS); this investigates the interaction between technology and society, instead of treating them as separate entities (Wajcman, 2002; Williams & Edge, 1996). Scripting suggests that the design and development of a technology involves a process of 'defining the identity of putative users, and setting constraints upon their likely future actions' (Woolgar, 1991, p. 59). Through this concept, attention is drawn to how the writing of a technology 'script' relies on the designer having an idea of the product's intended user, including, for example, their identity and characteristics. These user representations encompass 'specific tastes, competences, motives, aspirations, political prejudices, and the rest' (Akrich, 1992, p. 208). Whilst heating installers' selection and installation of central heating controls might already be scripted by the technology design (for example, installing the product in a particular location in relation to specific design features), it is the way in which these processes themselves might also script the end user that is of primary importance for this paper. More specifically, this paper explores the idea that, in the case of domestic heating controls, the process of scripting the user is not confined to design and development, but extends into the deployment and installation of these technologies.

In their front line position, interacting with end users on a daily basis, heating installers might derive their scripts from their experiences with customers. Such implicit methods, for example those relying on personal experience, 'expert' authority and experience with related products, can be widely applied in determining user characteristics. Organizations might also use a series of 'explicit techniques' for the development of user representations, namely market surveys, consumer testing and feedback on experience. However, through simulating prospective users' behaviour and reactions, presenting 'typical' scenarios, and employing actors deemed to be representative of real-life users, these techniques can create idealised users that are quite distinct from real users (Akrich, 1995).

Therefore, for a new technology to be effective, imagined users and real users might have to be reconciled. Akrich (1995) identifies a series of strategies adopted to aid this alignment process, including delegating reconciliation of representations to 'outsider' intermediaries (p. 180). In Akrich's example of a home management computer with applications including house surveillance and programmed heating controls, it was the intermediary 'dealers' who were to 'sound out' the varied user characterizations for their individual needs and devise

a suitable system configuration accordingly (this included installation, programming and after-sales service) (p. 180). However, Rohrer (2003) notes the 'sometimes conflict-ridden' process between users, producers and other actors. In his study of ventilation systems, he identifies that intermediary installers might try to convince users of their own preferred vision of the technology design and use. Meanwhile, in Abi Ghanem's (2008, p. 201) case, it was the project managers – 'deciding where, how and in what way' photovoltaic panels were to be installed in both social and private housing case studies – who scripted users. These intermediaries, charged with the delivery of photovoltaic panels, confined users to 'project-friendly', passive, indifferent roles that ensured the smooth completion of installation (p. 201).

Heating installers meet end users in their homes on a daily basis; in this intermediary position they could play an important role in scripting the intended users of central heating controls, shaping the way that these devices are used and the subsequent energy consumed through space heating. In this way, whilst the notion of 'scripting' has traditionally been examined in terms of the assumptions that become embedded in technology design, this paper extends it with regard to how installers also draw on certain scripts when deciding what to supply and how these technologies should be talked about. The following empirical material examines the way in which 'scripting' applies in terms of how heating installers develop different user types that are treated differently in terms of the selection and explanation of heating controls. The results presented have been identified through this iterative analysis process, and are illustrative of the themes and ideas that were present across the whole sample. They are separated into two sections; the first investigates heating installers' perceived usability and associated selection of heating controls, whilst the second is concerned with their explanation of these devices.

Results

Results 1: heating installers' perceived usability of heating controls

The following empirical material investigates the characterizations of end users that heating installers use in order to make decisions about the room thermostats and programmers that are installed as controls for the central heating system.⁴ Certain users, and certain lifestyles were taken to warrant certain types of control, as Roy⁵ discussed during his interview:

What do they want out of out of the system, erm, 'are you and your husband workin[g], are you out the

house at certain times of the day', [...] is your weekend schedule different from your 5 day a week schedule, [you] know, you need real, real flexibility on times, if it's erm, a retired couple, they really can't handle that technology, the 5 day, 2 day, 7 days [...] they don't really need all of that technology, all they [want to] do really is stick it on manual, [because] the old boy might get up at 6 o'clock in the morning, he'll come downstairs and he'll switch it on [...] irrelevant of whether he's got an all singin[g] all dancin[g], so, it's extremely important that you sell the right control type to the right person.

(Roy, self-employed, interview)

Roy was not alone in identifying that user differences may be important in the selection of central heating controls. During this fieldwork, heating installers often talked about end users in general terms. Yet what also became apparent was how they identified particular user types in relation to heating controls. For example, older people were the predominant user type discussed, but young professionals, families and technologically aware users were all specifically identified in relation to particular controls. The heating installers involved in this study generally distinguished between three different types of heating control; mechanical, digital and smart. They highlighted factors affecting their usability, and their suitability for different user types; these characterizations are detailed in the following section.

Mechanical devices

Heating installers often regarded mechanical devices, like those illustrated in Figure 1, as the simplest control option. These include the round mechanical thermostat, a device with a dial that is twisted to indicate the desired temperature setpoint, and a 'push-pin' programmer where pins are pushed in to set the on-off times for the heating. This is perhaps unsurprising when these mechanical devices were the first modern means through which to automate a central heating system. Although

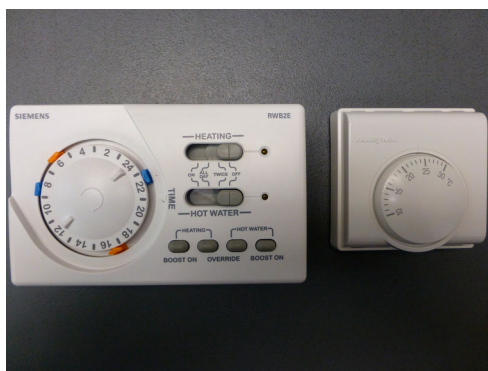


Figure 1. Example of a mechanical thermostat and programmer with 'pins' to manage on-off times. All images are authors' own.

the round thermostat was first introduced in the 1950s (Peffer et al., 2011), these continue to be installed in homes today. Gary and Dale noted that although these are 'archaic', they are often still sold because 'everyone knows' them and 'they're just easy to work' (Gary and Dale, sales representatives, interview). Similarly, Ben noted that people 'like what they're used to [...] in general, people want to see a dial on the wall' (Ben, organization, interview). Thus, generally, the ubiquity of mechanical devices made them a straightforward option to install. However, these devices were also particularly noted for their suitability for older people, who just want 'on or off' (Martin, self-employed, interview). Phil, a course instructor at one training session, nicknamed the mechanical thermostat 'the granny stat', highlighting that it was 'idiot proof' and 'if you can't use this product, then you shouldn't be left on your own' (Phil, manufacturer training, field notes). Through detailed observation it emerged that these mechanical devices were selected because of their perceived widespread familiarity, but also because of their suitability for those deemed to be least technologically competent, particularly older people. In restricting the devices selected for certain groups, these heating installers were scripting them as users who are provided with limited functionality and flexibility because that is what they were assumed to need.

Digital devices

Digital devices, like those depicted in Figure 2, began to emerge in the 1990s (Peffer et al., 2011), and are commonly installed in homes. These devices tend to use digital screens, and buttons labelled with symbols. With the capacity to store data, these devices have greater flexibility than their mechanical counterparts, including the ability to have different temperature settings at different times and on different days of the week. Heating installers suggested that this programming capacity makes



Figure 2. Example of digital programmable controls.

these devices suitable for working people and families who may have particular routines. For example, *Roy* noted that working users are likely to be 'out the house at certain times of the day' and have different weekday and weekend schedules, that can be accommodated with digital controls (*Roy*, self-employed, interview). One participant noted that these devices were suitable for a 'young, professional couple' who would be happy with the 'nice blue screen on it, nice touchscreen type controls' because they are 'a bit more technical' (*Jack*, self-employed, interview). Indeed, the perceived complexity of these devices led them to be compared to computers, with 'younger people who come from the laptop days' being most able to understand them (*Carl*, self-employed, interview). It is in part their relation to computers that led these digital devices to be regarded as unsuitable for older users. As *Jack* noted:

It's almost like teachin[g] someone [h]ow to use a laptop, and they've never used one before, or say an iPad, easy enough to understand if you work with computers, but if you've never worked with one and you say 'right, [h]ere it is', do this, this and this, and they don't, they don't even know the sequence of [h]ow to start it up, [h]ow to get the programmer to work, [h]ow to get the times put in.

(*Jack*, self-employed, interview)

Beyond a lack of familiarity with these 'computerised' devices, some participants highlighted the limitations that might be placed on older people by the visual and dexterity requirements of digital controls (*Carl*, self-employed, interview; *Ben*, organization, interview). According to installers, the requirements scripted into the design of digital controls make them unsuitable for some users, particularly older people. As such digital controls were more likely to be offered to those with more familiarity with computer-like devices, for example young professionals.

Smart devices

Fieldwork for this paper was conducted in 2013, when smart heating controls were far less prevalent than they are now; however, they did sometimes feature in heating installers' conversations. Amidst promises regarding their ease of use, flexible operating options, and energy saving potential, smart heating controls are currently receiving significant attention from the heating industry and policy-makers (DECC, n.d.). However, achieving their promised benefits will be influenced by the way in which these products come to be in the home. These devices, illustrated in [Figure 3](#), usually include a digital user interface (a touchscreen, for example) and



Figure 3. Example of smart heating controls.

may encompass the use of multiple technologies, for example allowing remote operation of the central heating via a laptop or mobile phone. It was suggested that these advanced devices might be suitable for 'somebody that's clearly intelligent, clued up, maybe an engineer or something like that', who will want the 'fanciest thing going' (*Gary* and *Dale*, interview). During his interview, *Roy* referred to a particular brand of smart programmable room thermostat that you could 'turn on from your laptop in Tokyo', suggesting that this was most suited to 'upwardly mobile office people' (*Roy*, self-employed, interview). Meanwhile, *Phil*, a sales representative for a controls manufacturer, thought that controls with an 'iPhone app' were for 'people who wanted to show off' (*Phil*, field notes, sales rep). In another example, *Chris* told the story of a 'techy guy' who had 'found this new control from America'. *Chris* had not installed this control before, and had to spend some time understanding the new technology before he could install it (*Chris*, install – organization, field notes). Thus, smart controls can elicit the need for additional learning from the heating installer, and may also be scripted towards those that heating installers deem to be the most technologically aware.

Results 2: Installer explanations scripting the use of controls

The following section explores the way in which heating installers' ideas might influence the setting and explanation of central heating controls, and, as such, the understandings that they provide end users with. It considers heating installers' ways of engaging with end users in general, but also how these varied for specific types of identified user, and how these strategies might script the subsequent use of these devices.

Suggested settings

According to one manufacturer training course instructor, 'it's scientifically proven that the human is

comfortable between eighteen and a half and twenty one and a half [°C]' (manufacturer training, audio). When discussing how to help end users reach this comfort band, *Shane*, another course instructor, offered the following strategy:

I suggest for the first two days, run it at 22 degrees, for the next two days, turn it down, each after two days and go down to 21 degrees, turn it down again, if you still feel comfortable, turn it down. Turn it down until you feel too cold and then you go back up one degree and you know you're there.

(*Shane*, manufacturer training, audio)

By encouraging users to start at 22°C and incrementally reduce the thermostat setting, it might be that they settle at a higher temperature than they perhaps would if starting from a lower temperature. Meanwhile, some participants said that they advised end users to keep the heating on constant, but at a lower temperature, with the justification that this strategy was a more energy efficient and cost-effective way to operate the central heating system. One training instructor elaborated on this, highlighting that:

14 degrees to 18–19 degrees is not a lot of work for your boiler to do first thing in the morning. 6, 7 degrees to 19 degrees is a lot of work for your boiler to do, and that's where people's heat, heat loss tend to happen the most.

(*Phil*, training instructor, audio)

This recommendation is based on the understanding that it is better to retain the heat in the fabric of the building, and that the boiler operating at a lower output, but more regularly, is more efficient. For example, this strategy was suggested by *Gary* during an installation, where he highlighted to the end user that 'keeping the fabric of the building tickin[g] over' was the best strategy (*Gary*, organization, installation). It is worth noting that the installers' suggested temperatures, between 19 and 22°C, are in line with international thermal comfort standards (ASHRAE, 2010). The energy consumed through the central heating system depends on the fabric of the building, and its capacity to retain heat; however, leaving the system on constant is likely to consume more energy than intermittent heating in homes of standard construction (EST, 2008).

Beyond suggested temperatures, it was observed how some heating installers would also physically set programmes for their customers at the time of installation. For example, *Brian* explained that he enters the settings into the digital programmable thermostat that he installs, according to a series of questions that he asks his customers:

I would say, 'what time is, what time d[o] you get up? What time d[o] you go to bed? Are you in during the day? or are you out and about?' And explain that

keeping your house warm is cheaper than cooling it down and heating it up again.

(*Brian*, self-employed, interview)

In this way, *Brian* can ensure that the end user's settings are appropriate for them, perhaps also limiting their need to interact with the device in the future. However, some heating installers also noted that they would provide settings based on their assumptions about particular user types. For working customers, *Jack* would set the system to come on 'half an hour before they get up', and off again 'fifteen minutes before they go to work', he would then suggest a second evening heating period (*Jack*, self-employed, interview). For a family scenario, one training instructor suggested that cooler settings might be used during the early evenings, 'sort of 16 degrees', whilst 'the kids are coming in from school, they're running around frantic'. Meanwhile, later in the evening, 'when you've, err, put them upstairs to do their homework and you just wanna sort of settle down' you might 'up the temperature accordingly' (*Steve*, training, audio). Meanwhile, *George* noted that some of the privately renting tenants he comes across 'haven't got a clue', so they will leave the programmer with 'whatever the installer has left it at', and to control the system they operate it with the power switch on the boiler (*George*, self-employed, interview). It was also suggested that social housing tenants sometimes operate the system in this way. By physically setting the device based on these questions and assumptions, heating installers are actively scripting the way that these customers might come to use their heating. Alternatively, heating installers might offer simplified explanations of controls to accommodate the limited understandings that they perceive end users to have of these devices. These simple explanation strategies are elaborated in the following section.

Simple explanations

Quite apart from a matter of energy use or efficient operation, it is beneficial for the heating installer if the end user is able to understand and use central heating controls in such a way that they do not experience problems, which might lead to call backs. These are when a customer asks a heating installer to return to the property because they believe their system to be working incorrectly, or because they cannot operate it. Call backs are usually conducted at the expense of the heating installer, done as a favour to the customer and to retain a good relationship with a view to future work and recommendations. *Ben*, the owner of a medium-sized installation company, estimated that 'at least 80 per cent of [their] call backs are due to tenant misunderstanding of the

controls [...] or not knowing what they are supposed to do' (*Ben*, organization, interview).

Repeatedly evidenced in the routine talk of heating installers was the perception that end users generally did not understand their heating controls. For example, *James* noted that the technology 'baffle[s] them' (*James*, organization, interview), whilst *Gary* highlighted that for the more complicated devices, 'the majority of their function just goes unused' (*Gary*, sales representative, interview). As *Jack* said: 'the more complicated they are, it's almost like you're gonna frighten them and they don't wanna know' (*Jack*, self-employed, interview). *Roy*'s description was more extreme again, he noted that his older customers were 'panic stricken' by a particular device that was specified by the organization he worked for. *Roy* adopted a simple explanation strategy in order to overcome the complexity of this device:

What I do say to [them] is that I'll put it on manual for you, treat the plus and minus as an on off switch, if you want the heating on, press the plus button, keep your finger on it, it goes up to 30, don't go up any more. If you want the boiler off, press the minus button, it goes down to 5, it is off.

(*Roy*, organization, interview)

Instead of detailing the operation of this digital device, *Roy* sets the system up so it is on 'constant', and is controlled simply by requesting a higher or lower temperature at the thermostat. The use of this complex, digital device has been scripted to include only two buttons, the plus and the minus that control the temperature. Similarly, *Ibrahim* explained that he would ask the end user what they want to do with the heating, if they just want to turn it on and off then he 'sets the timer' and 'tells them to just operate it by the thermostat'; more specifically, he tells them to 'just turn the dial up or down' (*Ibrahim*, manufacturer training, field notes). *Ibrahim* noted that this simple explanation is ideal for end users because 'if it's anything more than the basic facts, they just forget', but also for himself because he 'very rarely' gets call backs, unless it is another company that has performed the installation (*Ibrahim*, organization, interview). Thus, the heating installer's advice can be informed by their perceptions of end users' limited understandings, fear, or their own desire not to receive call backs. Whilst installers might offer more complex explanations to those customers deemed to be more capable, the simplified explanations discussed here were both related to specific types of end user, for example older people, but also users in more general terms. However, regardless of heating installers' reasons, these simplified explanations provide limited information and can script complex controls into basic switches.

Discussion: the implications of heating installers' scripting

This fieldwork revealed the variety of strategies applied by heating installers in the selection and explanation of domestic heating controls. This decision making process might be shaped by the installer's familiarity with particular products, the time and costs associated with learning different devices, along with the preferences and budget of the end user. However, installers also select particular devices for particular users and talk about them in certain ways. Through this process, installers might limit the level of control, functionality and flexibility available to users. Furthermore, through suggesting temperatures, physically setting control devices on behalf of them, and providing simplified explanations, heating installers can script the subsequent use of these devices, and not always in ways that promote energy efficiency. By demonstrating the significant role that heating installers can play in the selection and explanation of central heating controls, these findings serve to support Munton et al.'s (2014) suggestion that these actors are a potentially important influence on energy savings through domestic heating controls. The implications of this scripting process for decision makers in government and industry are now discussed.

Heating installers influence usability through the selection of controls

Heating installers distinguish between the suitability of mechanical, digital and smart controls for different types of user. In keeping with previous studies that have identified the difficulties that older people might have in using digital heating controls (Caird & Roy, 2008; Combe et al., 2011, 2012, 2013; Sauer et al., 2009), heating installers sometimes reserve these more complex devices for those perceived to be more technologically competent. The participants of this research also compared digital heating controls to computers, reflecting Peffer et al.'s (2011) assertion that heating controls are increasingly borrowing buttons and conventions from the computing domain. It was, in part, this similarity that led heating installers to suggest that those more familiar with computers, or from 'the digital age' may be more comfortable using digital heating controls. Meanwhile smart controls were reserved by heating installers for the most 'tech savvy' users. Thus, before attempting to get more advanced heating controls into homes, it is essential to test the extent to which heating installers' ideas about users are correct. Furthermore, it is important to explore how to work with the ideas that heating installers have about end users, especially

when seeking to promote certain types of device. This is particularly true if the realization of energy savings rests upon the installation of advanced and smart heating controls, which may not be installed in homes because of the current user scripts employed by installers.

Heating installers script use through the provision of advice

It is not only the controls themselves but also any accompanying advice that might script users' subsequent interaction with them. Through their provision of advice, the heating installer acts as one of the 'folk channels' that Kempton (1986) previously identified for perpetuating theories of home heat and how it should be organized. One proven strategy that heating installers use for minimising call backs due to limited end user understandings is to provide simplified explanations of the controls, for example the suggestion to leave the system on constant and simply operate it via the thermostat. Whilst on constant, the central heating will turn on whenever the room temperature drops below that set on the thermostat, as opposed to coming on and off at set times throughout the day. There is a perception amongst installers that some users are neither interested in, nor able to understand, their controls.

Furthermore, not only do these brief explanations foster the idea that the thermostat operates as a switch for the whole central heating system, they are also likely to contribute to the perception amongst users (identified by Rathouse and Young (2004)) that installers do not have the time to explain controls properly. If both groups feel that the other has little time or interest in talking about controls, a set of potentially erroneous assumptions is standing in the way of central heating being used in the most effective ways possible. Industry professionals and policy-makers might therefore want to encourage installers to communicate more fully about central heating controls. Whilst the level of detail a heating installer provides can be dependent on the type of user, if customers are interested and installers are willing this could represent a relatively easy but nonetheless powerful energy saving intervention. Based on this research, an obvious start would be to feed this into the installer training days that are already taking place.

Limited explanations can also reinforce limited understandings, restricting users' subsequent interaction with their heating controls (Caird & Roy, 2008; Rathouse & Young, 2004). If customers are advised to only interact with the thermostat, it is unsurprising that they do not always recognize, or use, their other heating controls, such as programmers (Rathouse & Young, 2004; Revell & Stanton, 2014; Peffer et al., 2011). Furthermore,

these simplified explanations can result in simplified control strategies that may lead to higher energy consumption. This is particularly true of the suggestion to leave the heating on constant and operate the device from the thermostat, and to maintain heat in the fabric of the building by keeping the heating on for longer at lower temperatures. The requirement to install controls is currently stipulated in the Building Regulations. However, in order to achieve desired savings, these findings indicate that these requirements should be supplemented with robust guidelines for how these devices are to be set up and explained. It is clear that, amidst the variety of strategies employed by heating installers in the installation and explanation of heating controls, the guidance provided in the HHIC's Commissioning Checklist to demonstrate the operation of heating controls is open to interpretation. Industry might therefore benefit from revising these guidelines, scrutinizing what user understandings are desired and whether heating installers' current strategies are sufficient to achieve these.

For future research, two avenues seem particularly fruitful to develop the insights presented here. Firstly, the concept of scripting has previously primarily been applied to those involved in the design and development of technologies. The findings revealed through applying this idea to heating installers suggest that it would be insightful to extend future investigations of scripting to include other actors operating in the built environment who also influence the choice and use of technologies in buildings, e.g. plumbers, electricians and those involved in the sale of domestic appliances. It is likely that similar actors operate in different countries, and so these investigations could be extended internationally to uncover how this scripting process varies with different technologies, properties and regulatory frameworks. Secondly, the extent to which the distinctions that heating installers identified amongst their customers actually exist within the population is currently unknown. Rubens and Knowles (2013) identified that end users may want different things from their heating controls, but this has not yet been examined in terms of the socio-demographic factors that heating installers use to profile their customers (such as age and employment status). A logical next step would be to establish whether these different user types exist, whether they match the socio-demographic characteristics identified by heating installers, and how widespread they are in order to support the more successful alignment of users and controls in future.

Conclusions

Heating installers distinguish between mechanical, digital and smart heating controls, assigning these based on

their understandings and assumptions about end users. For instance, the ubiquity and perceived simplicity of *mechanical devices* means that they are still regularly installed, in particular for older people. In contrast, the programming capacity of *digital controls* resulted in them being perceived as suitable for those with routines, such as working people and families; however the complexity of these devices led them to be compared to computers and allocated to younger people and those perceived to be most computer literate. Meanwhile, *smart heating controls* were suggested to be suitable for only the most technologically competent of users. Heating installers were also found to suggest *settings* for heating controls, including operating temperatures and times. Finally, they can also provide simplified *explanations* of heating controls, both based on their ideas about users, and a desire to minimize 'call backs' after installation. These findings indicate that policy-makers and industry need to consider the extent to which installers' ideas about users are correct and how they might encourage these groups to communicate more fully about central heating controls.

Heating controls are promoted for their potential to reduce the energy consumed in domestic buildings, and heating installers are at the frontline of how people become acquainted with them. Drawing on a programme of ethnographic work and theories of scripting, this paper has demonstrated that heating installers can script the types of devices that end users receive and the ways in which they will likely be used thereafter. Thus, it is essential that heating installers are more fully considered in future research and policy-making that seeks to understand and influence the energy consumed through domestic space heating.

Notes

1. The term 'heating installer' is used throughout to identify the individuals tasked with the design, selection, installation and commissioning of gas central heating systems. The specific skill set and qualifications that these individuals possess is quite distinct to that of a plumber (who traditionally works on water pipework, but not gas) and is also recognized by the term 'heating engineer' by those in the UK heating industry.
2. The data presented in this paper are denoted according to how they were collected (through observation or interview), along with the type of participant (whether they were self-employed or working for an organization).
3. Personal email communication ('research into central heating installation – request for information') with the head of communications at Gas Safe Register, 4 December 2013.
4. The selection and installation of a third control component, TRVs, was not discussed at length by the

participants of this research, and so does not feature in the analysis presented.

5. Pseudonyms (shown in italics) are used throughout to protect the anonymity of the individuals and organizations who contributed to this study.

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